Transgrid

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Market Metering Renewal and Maintenance Strategy

AMS Asset Class Strategy

2021/22

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Table 1 Change from previous version

Revision no	Approved by	Amendment
7	A. McAlpine – A/Head of Asset Management	Review and update to deliver the 2021/22 Network Asset Strategy.
6	L. Wee – Head of Asset Management	Review and update to deliver the 2020/21 Network Asset Strategy.
5	L. Wee – Head of Asset Management	Review and update to deliver the 2019/20 AM Strategy and Objectives.
4	L. Wee – Head of Asset Management	New document structure Review and update to deliver the 2018/19 AM Strategy and Objectives.
3	M. Jones – A/Manager/Asset Management	Review and update to deliver the 2017/18 Business Plan and further enhance the strategy.
2	L. Wee – Group Manager/Asset Strategy	Review and update to deliver the 2016/17 Business Plan and further enhance the strategy.
1	L. Wee – Manager/Asset Strategy	Separated into standalone document, review and update to deliver the 2015/16 Corporate Plan and further enhance the strategy.

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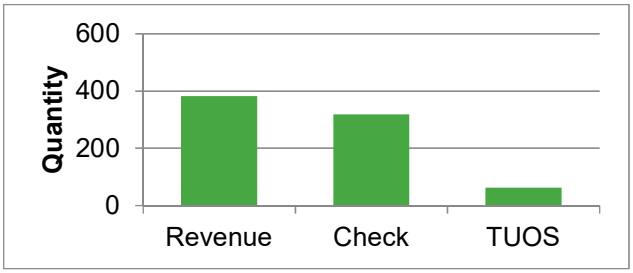
Executive Summary

Market Metering Systems installed throughout the network are utilised for the purposes of market settlement and are the core of the economic component of the National Electricity Market (NEM). Managing the risks associated with an ageing population and adapting to new technologies are challenges requiring a consistent and aligned approach to maximise value.

Asset Review



The Market Metering Systems portfolio can be summarised as those assets which are utilised for the measurement of energy for the purposes of billing and settlements. This comprises 700 NEM revenue and check meters, 62 TUOS meters, as well as related devices that are used to store and transmit the metering data including data loggers and modems. The systems installed predominantly consist of modern microprocessor meters. However, there is a small number of discrete component type meters which are an obsolete technology and are expected to be removed from the system within the current year.

Being an accredited metering service provider, Transgrid is obligated to operate and maintain the metering systems installed on the network in accordance with the regulatory requirements set out by the Australian Energy Market Commission (AEMC).

During 2020/21 Metering System assets underwent the following developments:

- Improved asset data and continued collection.
- Improved management to meet statutory obligations.

Achievements

In 2020/21 Digital Infrastructure achieved significant goals around Metering Systems including:

- Update of the information system to ensure that all market meters are captured accurately.
- Addressing the AEMC driven rule change regarding metering intervals moving from 15 to 5 minutes.
- Successful completion of the trial using CT Analysers which is a safer alternative method for testing CTs
- No non-compliances identified by AEMO in audits of Transgrid's Metering Coordinator and Metering Provider accreditations.

Challenges

- Obsolescence of certain meter types, components and technologies.
- Upcoming withdrawal of serial protocol based copper (PSTN) and 3G telecommunications services from Telstra
- Challenges integrating market metering with the deployment of IEC-61850 solutions
- Accurate and consistent record of Logical based metering schemes

Initiatives

- Establishing IP connectivity for meter modems to adapt to future requirements
- Continual improvements in asset data to increase the efficiency and accuracy of works

Contents

List of Tables

List of Figures

1. Foreword

1.1. Foreword

This document defines the renewal and maintenance strategies for Transgrid's Metering Systems fleet. In doing this it applies the overarching asset management strategy and objectives, and relevant Lifecycle Strategies.

The document identifies the emerging issues with Transgrid's Metering Systems assets, and details the renewal and maintenance initiatives to be implemented in response to these issues. The output of the strategy is the asset management program of works, which is derived via distinct paths as follows:

- The renewal and disposal initiatives are considered through the Prescribed Capital Investment Process and managed through the Portfolio Management group, which then leads to the resource-optimised capital works program.
- The maintenance initiatives directly drive the maintenance regimes which are detailed within the relevant Maintenance Plan. The Maintenance Plans are then resource-optimised through Transgrid's Enterprise Resource Planning (ERP) system, Ellipse and supporting applications such as TRAC.

The strategies contained in this document cover the prescribed assets for a ten year period from July 2022.

1.2. Overview

We have reviewed the historical technical performance and capital and operating expenditure for Market Metering assets within the network and we have determined that our current initiatives to date are successfully delivering our stated targets from last year.

The key initiative regarding the modernisation of our Metering systems has led to greater confidence in the performance of our assets with increases in issue detection due to alarms. This indicates that we are no longer relying as heavily on preventative maintenance to identify failed components of the network.

Overall performance between 2015/2016 and 2020/21 has seen:

- An overall reduction in unitised capital expenditure
- A minimised maintenance portfolio meeting our regulatory requirements

Transgrid has recently updated the Metering systems to comply with an AEMC driven rule change regarding metering intervals moving from 15 minute to 5 minute.

A Control Assurance Review (CAR) was undertaken to review the processes around metering installation, data, and testing management. No significant gaps in the controls currently in place were identified. Moreover, an AEMO audit into Transgrid's Metering practices resulted in zero non-compliances being found. However, documentation of the process of recording and updating testing method uncertainties has been identified as an opportunity for improvement.

A review of certain emerging issues have identified the need for urgent expenditure to meet the most critical changes:

- A technological shift by telecommunications providers withdrawing support for our currently implemented metering data connectivity protocols

In addition to the emerging issues, initiatives are continuing to:

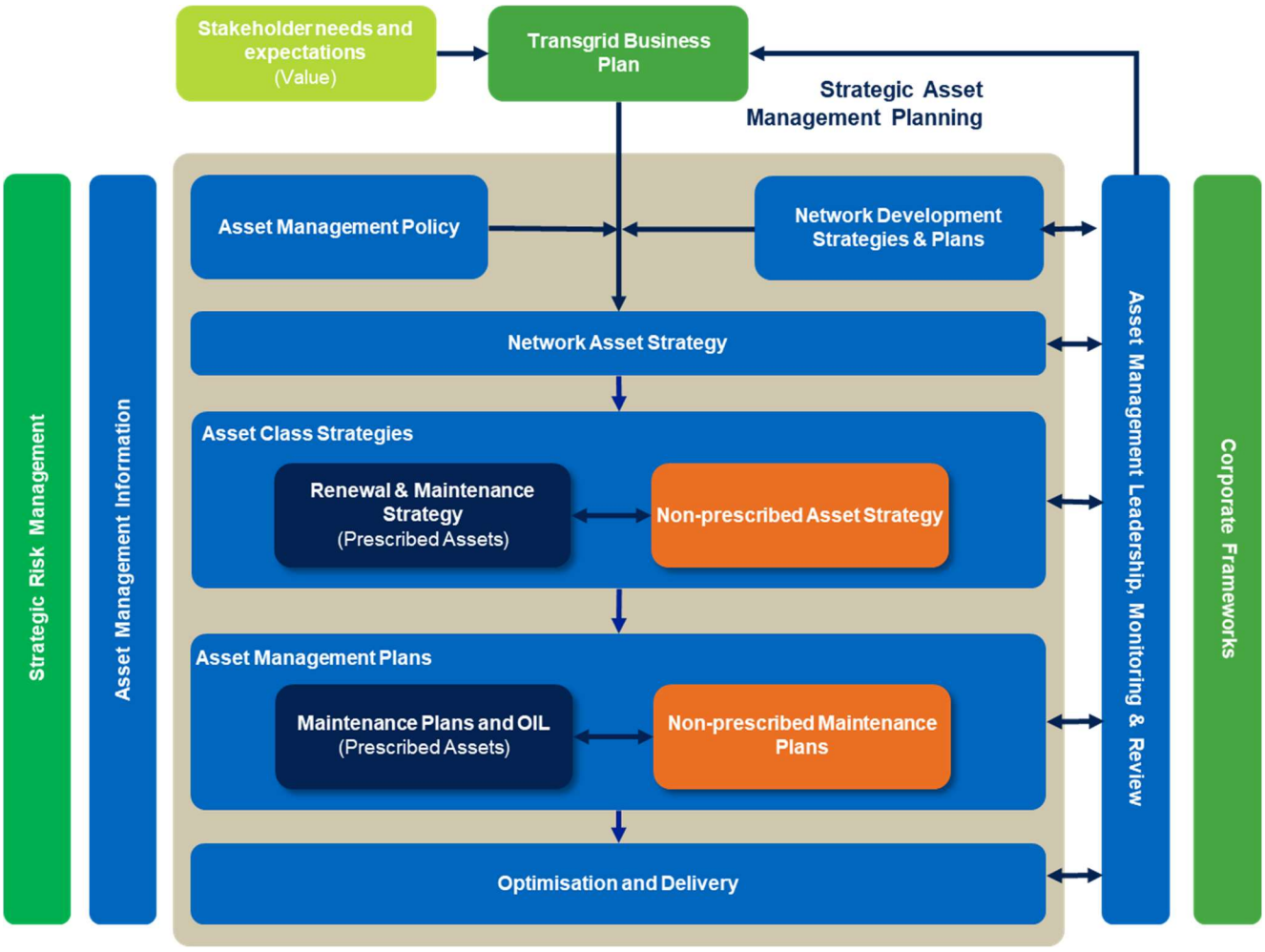
- Limit components in any metering scheme – effectively reducing corrective maintenance costs and scheme unreliability
- Improve asset data confirmation processes – which will increase efficiency and accuracy of works initiated
- Explore alternate methods of testing – leading to greater safety and cost effectiveness

2. Context and Background

2.1. Relationship to Asset Management Systems

This Renewal and Maintenance Strategy document is one of several that comprise the Asset Management Strategies within Transgrid's Asset Management System. This document sits below the Asset Management Strategy and Objectives document as shown in Figure 1.

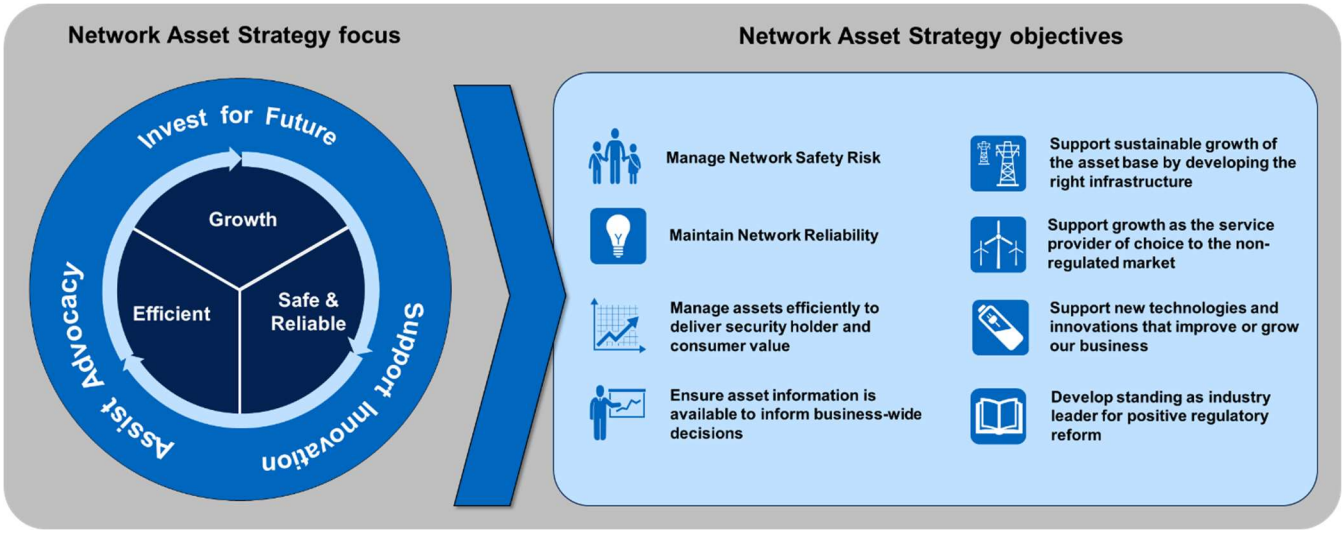
Figure 1 Asset Management System Hierarchy



2.2. Asset Management Line of Sight

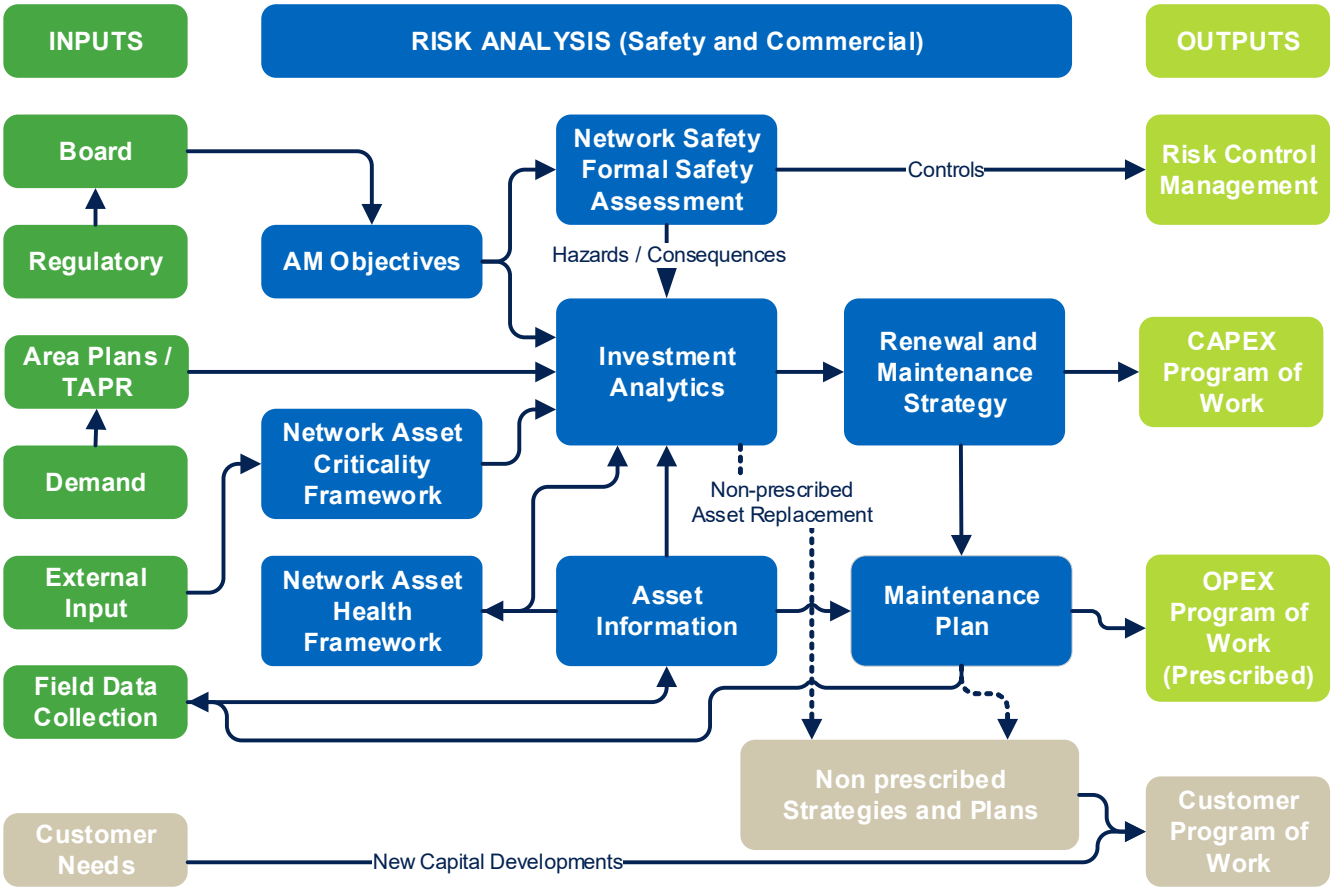
The renewal and maintenance strategic initiatives set out in this document support the achievement of the strategies set out in the Network Asset Strategy. The strategic alignment of the initiatives in this document to the Network Asset Strategy is based on meeting its strategic themes.

Figure 2 Network Asset Strategy Key Themes



2.3. Renewal and Maintenance Process Overview

Figure 3 –Investment Development Framework



2.4. Asset Overview

2.4.1. Scope of Assets

The following Market Metering assets are within the scope of this strategy:

- NEM Meters
- TUOS Meters
- Metering Modems
- Data Loggers

The following assets are outside the scope of this strategy:

- Statistical Meters – Automation Systems Renewal and Maintenance Strategy
- Quality of Supply Monitors - Automation Systems Renewal and Maintenance Strategy

2.4.2. Metering Services

Metering assets are utilised for the measurement of energy for the purposes of billing and settlements. These are connected to the following primary assets:

- Transmission Lines
- Transformers
- Reactors
- Capacitors

Metering assets serve our business as well as a variety of connected customers including Distributors, Generators and large commercial customers. These assets are utilised by AEMO to carry out market settlements.

The assets are comprised of two technology categories with different estimated technical lives as outlined below:

- Discrete Component Meters - 25 years
- Microprocessor Meters - 15 years

Table 2 Metering Asset Base

Metering Type	Quantity	Description
NEM Microprocessor	669	These installations provide settlement data for the management of the NEM by AEMO. These installations utilise modern meters with additional functionality and self-checking features. These assets have an estimated technical life of 15 years.
NEM Discrete Component	21	These installations provide settlement data for the management of the NEM by AEMO. These installations are much older utilising fixed components that measure by pulse the amount of energy throughput. These types of meters have limited to no self-checking functionality and rely on user actions to determine failures. These assets have an estimated technical life of 25 years.
TUOS Microprocessor	68	These installations provide inter Service Provider settlement data. These are used directly by Transgrid and DNSPs for calculating transmission use of system charges. These assets have an estimated technical life of 15 years.

The asset base still contains a minimal number of meters without self-checking features. This translates to a lack of visibility of the metering asset's condition and status (reliant on loss of data to alarm). It is noted that these remaining meters are targeted for renewal under current programs and will be replaced with self-checking microprocessor meters. It is expected that discrete component meters will no longer be installed on the network within the year.

2.4.3. Metering Modems

The NER and AEMO's Metrology Procedures require metering data to be made available to a number of stakeholders. Our approach to this has been to install modems at each site where market metering exists,

to allow external stakeholders direct access to metering data without the need to navigate through our physical and cyber network security protocols.

There are currently approximately 200 modems within the Network and are comprised of two technologies:

- PSTN Modems – These are modems that allow connectivity through a copper line, generally provided by Telstra.
- 3G/4G Modems – These are modems which connect through Telstra's mobile telephone network.

Metering telephone lines are leased from Telstra where a standard modem is applied. These lines, bundled with the associated modem, allow remote data access for our external stakeholders as per the requirements of the NER's Chapter 7.

2.4.4. Data Loggers

Data Logger assets are required to allow older discrete component meters to make data available for interrogation. These assets are obsolete and removed when the associated meter is upgraded to modern technology (within the year).

2.5. Spares

Our current strategy for spares is to maintain holdings which are proportional to the installed quantities in the network as per practices specified in the Spares Policy and Digital Infrastructure Spares Plan. Additionally, we monitor the support availability for the different assets and a scale is applied as support is diminished.

When notification is received for the withdrawal of support for a particular asset, a review of that asset's historical performance, age profile and population size is carried out. Based on this review we may decide to renew the assets with a modern replacement or purchase sufficient spares to support the assets towards the end of their technical lives.

3. Current Performance

3.1. Review of Previous Renewal, Disposal and Maintenance Strategies

This section discusses the performance of the current prescribed asset base.

3.1.1. Historical Expenditure

Historical expenditure has been analysed from Transgrid's RIN submissions between 2016/17 and 2020/21.

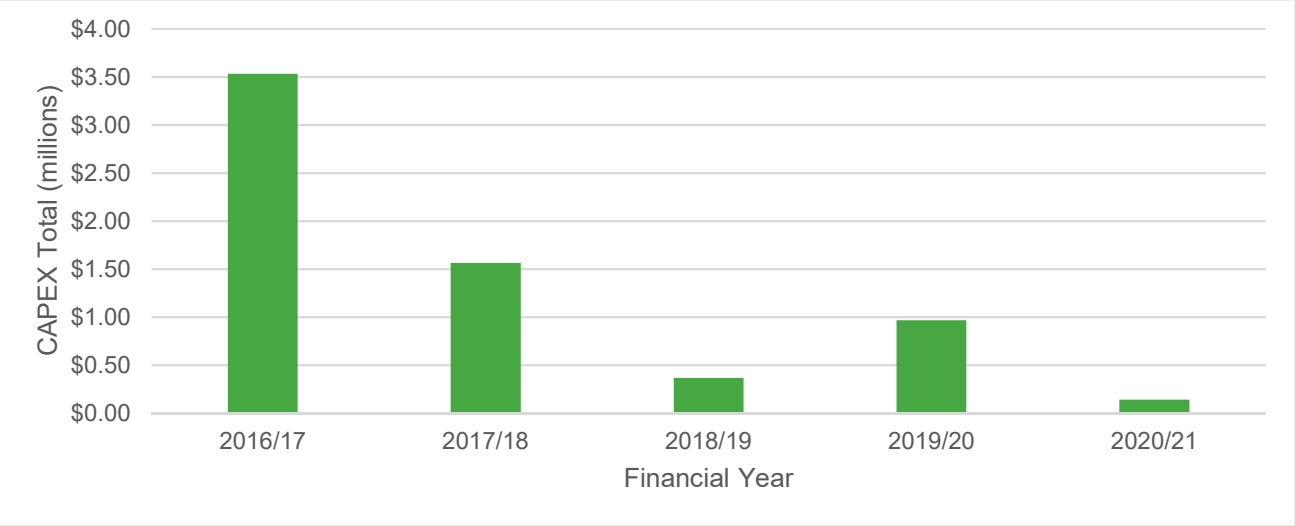
3.1.1.1. Capital Expenditure

Previous initiatives had identified a general move for Metering Systems to a run to fail approach. This was applied to most modern metering systems utilising modern principles and standards. A few assets that required significant effort to be upgraded to current standards, were invested in through capital expenditure.

Our current capital expenditure profile applies to Secondary System Renewals only at this time.

Overall, capital expenditure from 2016/17 to 2020/21 has decreased in alignment with previous strategic objectives. Note that the value for 2019/20 mainly comprises the metering renewals associated with the Sydney North Secondary Systems Renewal which is a relatively large site.

Figure 4 Total Historical CAPEX



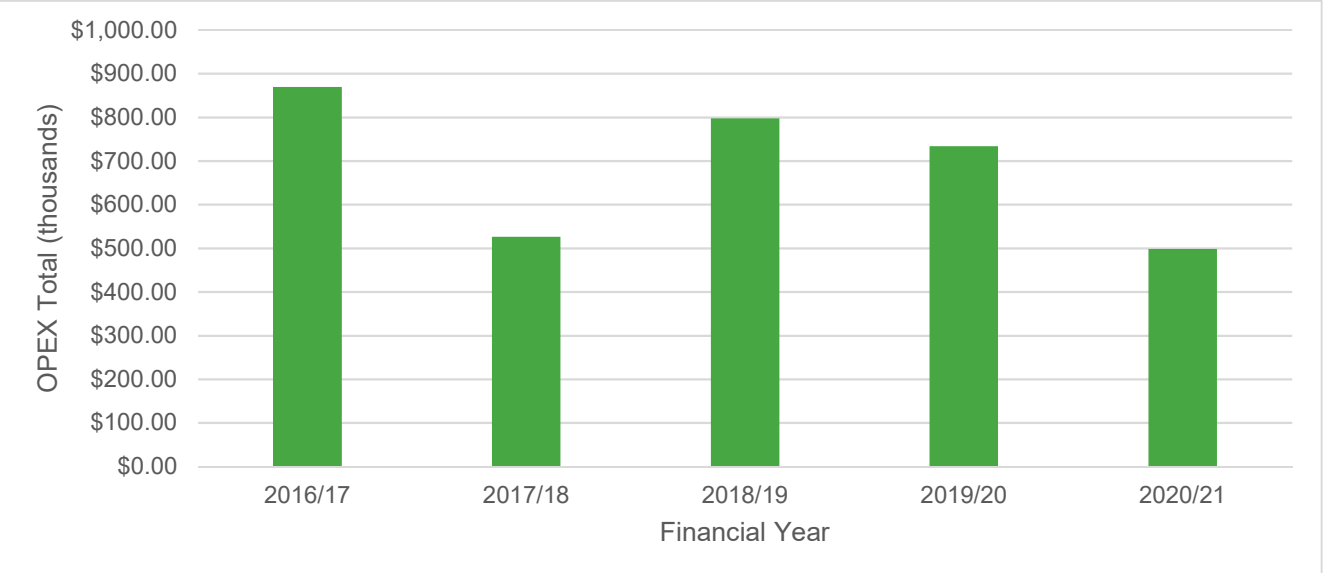
3.1.1.2. Operating Expenditure

Market Metering regimes are heavily regulated with the National Electricity Rules prescribing specific activities and their frequencies to ensure metering accuracy is met for billing purposes.

Previous initiatives had targeted a reduction in overall operating expenditure of the AMPoW. These reductions have been achieved through efficiency gains in maintenance delivery to reduce overall costs. These have been targeted through a review of maintenance activities and their frequencies. This has resulted in the historical downward trend of Operating Expenditure.

Fluctuations are expected in the OPEX due to the cyclic nature of Market Metering maintenance.

Figure 5 Total Historical OPEX



A review of maintenance performance for Automation and Metering systems, actual versus budget costs, for FY2021 is shown in Table 3 below.

Table 3: Maintenance expenditure FY2021- Automation and Metering

Maintenance Type	Actual $	Budget $	Variance $
Routine Maintenance	1,351,133	2,422,580	- 1,071,447
Inspections	19,278	27,537	- 8,259
Condition	405,318	475,000	- 69,682
Defect	892,920	952,222	- 59,302
TOTAL	**2,668,649**	**3,877,339**	**- 1,208,690**

Operating expenditure constraints in 2020/21 required the reprioritisation of maintenance activities. This had a direct impact on the overall planned maintenance for protection schemes whereby self-checking systems could have their activities delayed out of the financial year. This approach did not affect metering systems, which are part of the above summaries and did not place the network at significant risk.

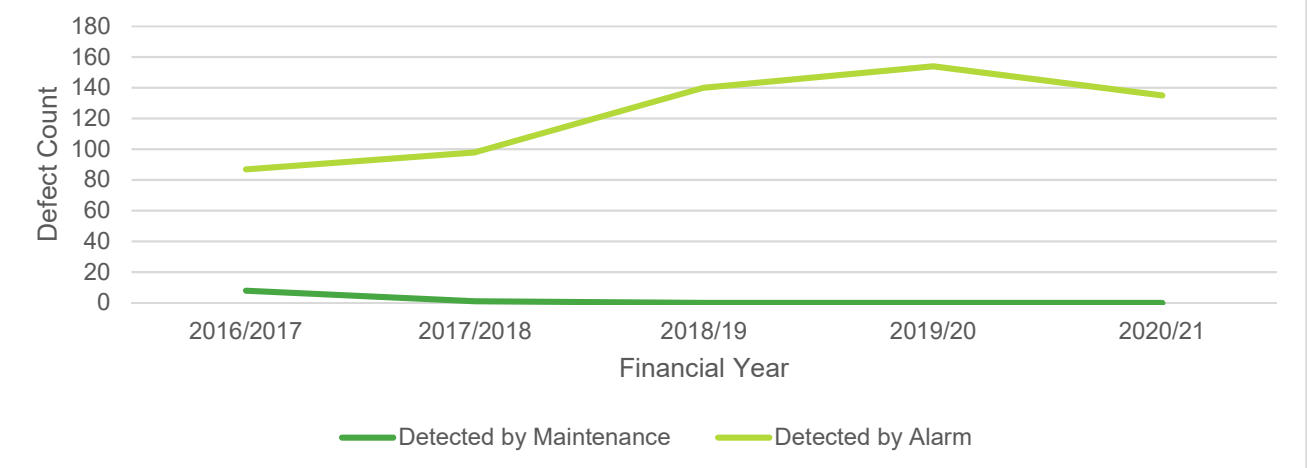
3.1.2. Review of Renewal and Maintenance Initiatives

Delivery of the existing Renewal and Maintenance Initiatives has continued to target the strategic objectives of Transgrid where:

- The investment can be shown to deliver outcomes and maintain our license
- The investment is required to manage risk and optimise returns
- The investment can increase future value through a competitive lifecycle

The historical investment in modern technology, particularly self-checking components, has allowed us to move from a reliance on preventative maintenance and data reading to identify issues. New assets offer a higher availability of diagnostics and real time notification of issues.

Figure 6 Historical Metering Issue Detection



As can be seen from the figure above, issues detected during preventative maintenance activities has reduced significantly throughout the last five years. As more assets are upgraded to modern technologies

and standards, we do not have to wait until planned maintenance is carried out to discover issues with the assets. This means there is higher confidence in the availability of our metering assets within the network.

An analysis of increasing defect trends has determined that there is an increase in metering scheme defects partly attributed to modem failures. This is being addressed through the move to mobile technologies using modern devices instead of like-for-like defect replacements.

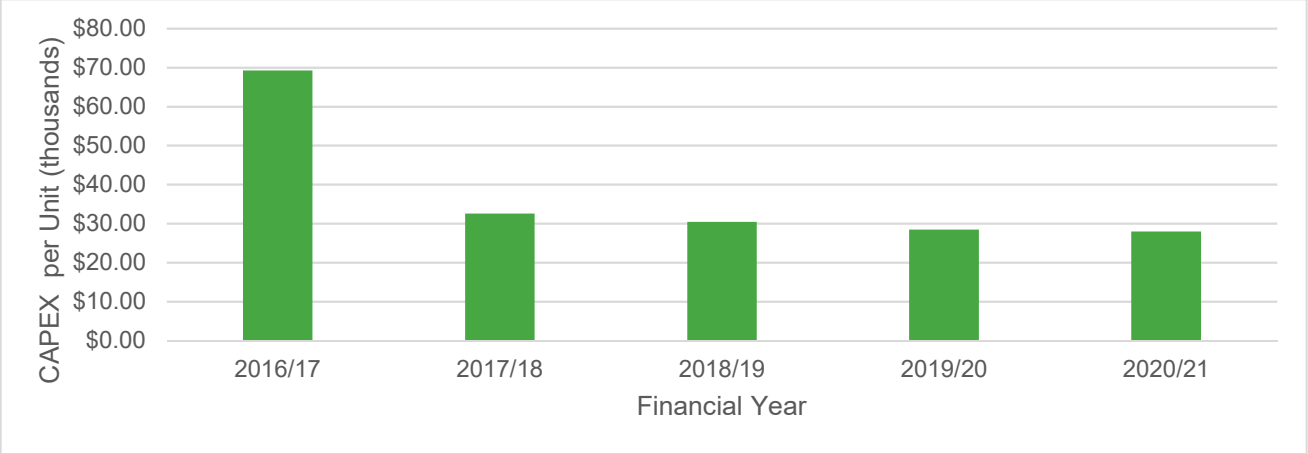
Planned maintenance activities are carried out to comply with NER requirements and provide confidence in the accuracy of our metering installations.

3.1.2.1. Capital Expenditure

When assessing the capital costs on a per asset basis, trends are decreasing, this can be attributed to a change in strategy from complete panel replacements (four meters per panel) to the application of targeted replacements inside existing panels where possible.

As we have attempted to move to site wide asset renewals which allow the upgrade of all associated infrastructure to maximise value from the latest technology and capabilities, there is a portion of unitised costs which reflect the additional infrastructure works associated with renewals which are absorbed into the larger project assisting in the reduction in unit costs.

Figure 7 Unitised Historical CAPEX



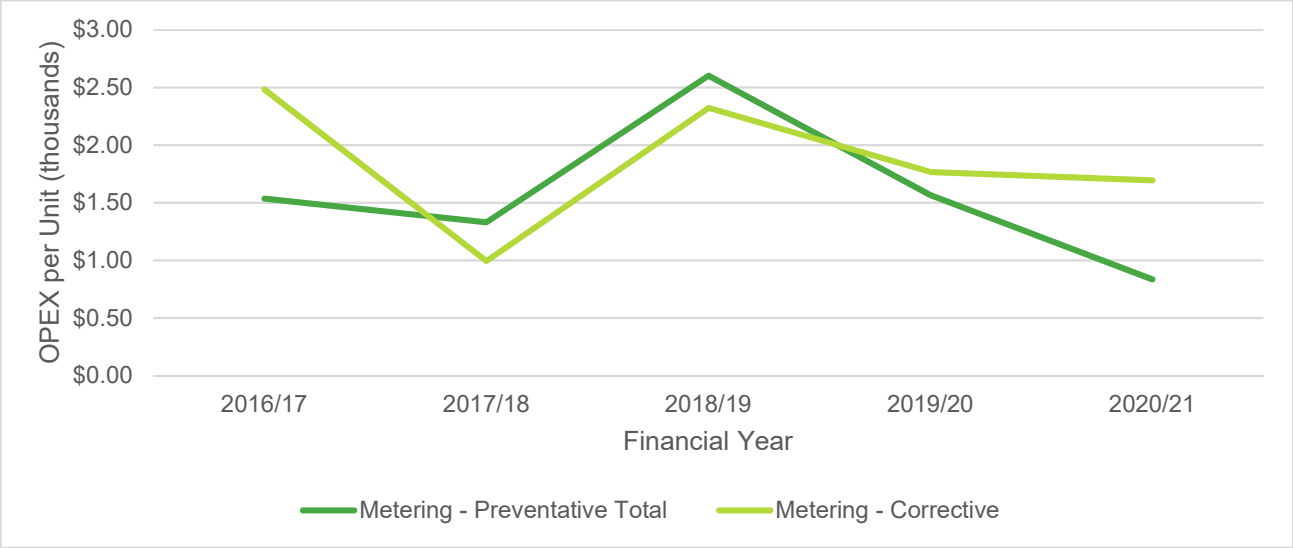
3.1.2.2. Operating Expenditure

Operating expenditure target reductions from the previous Strategy and Objectives have been met through the existing maintenance initiatives. This has been a result of several factors:

- Efficiencies in the delivery of maintenance tasks to maximise value from the assets
- Corrective maintenance cost reductions due to new technologies resulting in a faster and more cost effective return to service.
- Modern technologies consolidating multiple functions into a single asset. Resulting in reduced diagnostic times and faster return to service.
- The types of defects seen in the last year were of a nature that required significantly less effort to correct, being driven partly by modem failures and issues that were resolved by resetting the systems remotely.

Metering scheme related maintenance activities have seen a decrease in unitised costs per maintenance task across corrective activities. Preventative maintenance has remained constant as we are bound the NER and AEMO metering maintenance requirements our current maintenance strategy is to comply with the minimum requirements.

Figure 8 Historical Metering OPEX



A review of metering maintenance activities for 2018/19 determined the increase was caused by an increased number of accuracy checks. These are a generally more expensive maintenance task that is on a ten yearly cycle. Accuracy checks are additionally hampered by outage cancellations resulting in additional costs around rescheduling.

3.1.3. Past Performance – Asset Management Performance Indicators

The KPIs that demonstrate the effectiveness of this Renewal and Maintenance strategy to mitigate the network related safety, reliability environment, financial, compliance and reputational risks in support of the achievement of the asset management targets and objectives are the number of Key Hazardous Events. These measures have been maintained at a low level historically, indicating the Renewal and Maintenance strategies have been effective at mitigating the risks and achieving the asset management objectives.

KPIs are represented across both prescribed and non-prescribed assets. Across all outage types excluding Transmission Line & Cable Fault Outage Rates, Digital infrastructure assets have performed below the five year average for this asset class.

Historical KPIs and objectives are shown in Table 4 below. Updated Objectives and KPIs are shown in Section 4.1.

Table 4: Asset management objectives and performance indicators – Market Metering Systems

Transgrid Strategic Theme	Asset Management Objective	Asset Management Performance Indicators
Create an efficient high performing business	Manage assets efficiently to deliver security holder and consumer value	• 7.8% reduction in AMPoW delivery FY2021 *AMWP budget outcome was met in FY2021 (see* Table 3 *in Section 3.1.1.2)*

Transgrid Strategic Theme	Asset Management Objective	Asset Management Performance Indicators
		• Achieve efficiency on regulated capital spend FY2021 *Targeted capital efficiency was achieved in FY2021 and reinvested into the business.* • No major non-conformance in regulatory audits against Metering Coordinator and Metering Provider accreditations *Achieved in FY2021* • No red reports related to metering compliance provided to BARC. *Achieved in FY2021.*

3.2. Review of Strategic Initiatives

The status of relevant strategic initiatives from the Network Asset Strategy and other asset class specific strategic initiatives is provided in Table 5.

Table 5 - Strategic Initiative Status

Network Asset Strategy Objectives	Initiatives / Reference	Status
Deliver safe reliable power		
Manage Network Safety Risk Maintain Network Reliability	Implement a technical authority framework supported by competency assessment processes.	Scope of activities covered by the Technical Authority Framework has been developed. Technical Design competency framework developed with assessment process development underway.
	Review and revise Risk Assessment Methodologies to ensure our ability to quantify risk is both appropriate and balanced defensibly.	Risk Assessment Methodology has been updated and is under continuous improvement.
	Implement Critical Control Management for key areas of the business.	Ongoing
	Minimise numbers of deployed systems that pose safety risk	Ongoing
	Continuation of data collection with the use of CT analyser for CT testing, being a safer alternative to CT Saturation Testing which requires HV testing.	Initiative complete. The CT analyser has been authorised for CT testing resulting in improved safety.

Network Asset Strategy Objectives	Initiatives / Reference	Status
Create an efficient high performing business		
Ensure asset information is available to inform business-wide decisions	Continued collection of detailed asset condition data in AIM. Ready access to this data and integrating into the AAIT should empower the Asset Manager to make informed decisions. Improve asset performance monitoring through defect and AIM issue dashboards and analysis to inform asset strategies. Utilise newly implemented failure coding in AIM to allow better analysis and decision making.	Ongoing
Manage assets efficiently to deliver security holder and consumer value.	Control Assurance Reviews (CAR's) to identify weakness and non-conformances in metering asset management practices.	Two CAR's completed in FY2020/21.
	Development of information dashboards that provide relevant information to stakeholders to ensure asset management performance is accessible	Strategic risk dashboards have been implemented across operational and Executive committee meetings with further measures to be included in future iterations.
Invest in Transmission to support the energy transition		
Support sustainable growth of the asset base by developing the right infrastructure	Supporting the development of the Integrated System Plan and Renewable Energy Zone projects.	Ongoing - providing trusted advice for the development, procurement and design of new assets to achieve lowest lifecycle cost. Review and update of standard design manuals and IUSA functional specifications.
Support growth in our unregulated business		
Support growth as the service provider of choice to the non-regulated market	Supporting the development of non-regulated projects.	Ongoing - providing trusted advice for the bid and development of non-regulated opportunities. Non-prescribed maintenance plan developed. Works in progress to develop a non-prescribed spares plan.
Support new innovations and technologies		
Support new technologies and innovations that improve or grow our business	Establish IP connectivity for meter modems to facilitate future requirements.	Initial investigations complete with an unsuccessful outcome. Further investigations required to develop a solution by June 2022.

4. Strategy

4.1. Strategy and Objectives

All strategic initiatives with respect to Transgrid's prescribed Metering assets are outlined in this section, including the renewal and maintenance initiatives that contribute to the asset management program of works (AMPoW). Further details can be found in the relevant Metering Systems Maintenance Plan, and the referenced governance documents.

Table 6 Network Asset Strategy Objectives and Performance Indicators

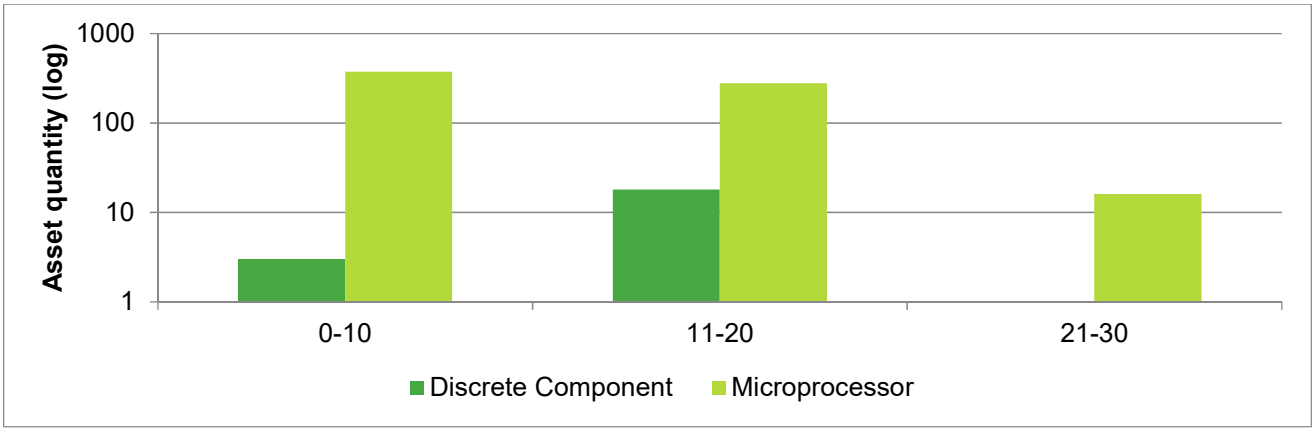
Transgrid Strategic Theme	Asset Management Objective	Asset Management Performance Indicators
Create an efficient high performing business	Manage assets efficiently to deliver security holder and consumer value	• Deliver AMPoW within +/- 5% • Delivery Capital Program within +/- 5% • Target capital efficiency improvements • No major non-conformance in regulatory audits against Metering Coordinator and Metering Provider accreditations. • No red reports related to metering compliance on Principle Risk Dashboards

5. Renewal and Maintenance Initiatives

5.1. Market Metering Assets Review

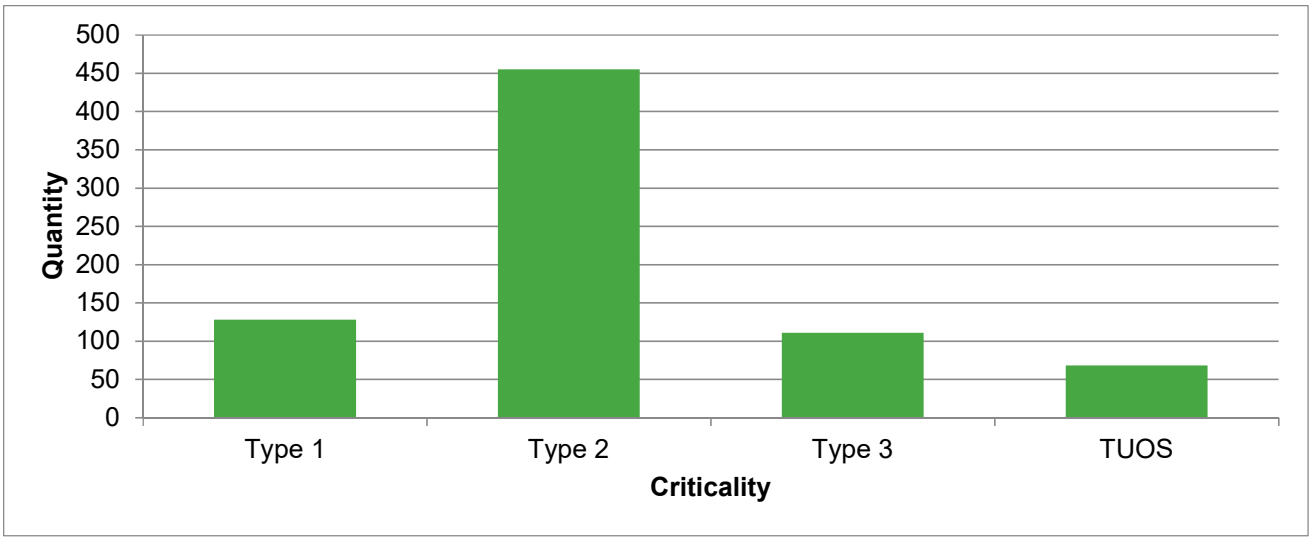
The current age profile of various metering technologies when compared to their estimated technical lives, identifies a small number of assets that have exceeded their life. Many of these end of life assets have been identified for renewal.

Figure 9 Metering Age Profile



Due to the nature of metering systems, their criticality is scored against the energy throughput of the metered point. Scoring is applied in accordance with the NER allocation of energy groupings. An additional TUOS criticality is applied which is the lowest priority as these metering points are purely for settlement between our business and certain connection points.

Figure 10 Metering Criticality

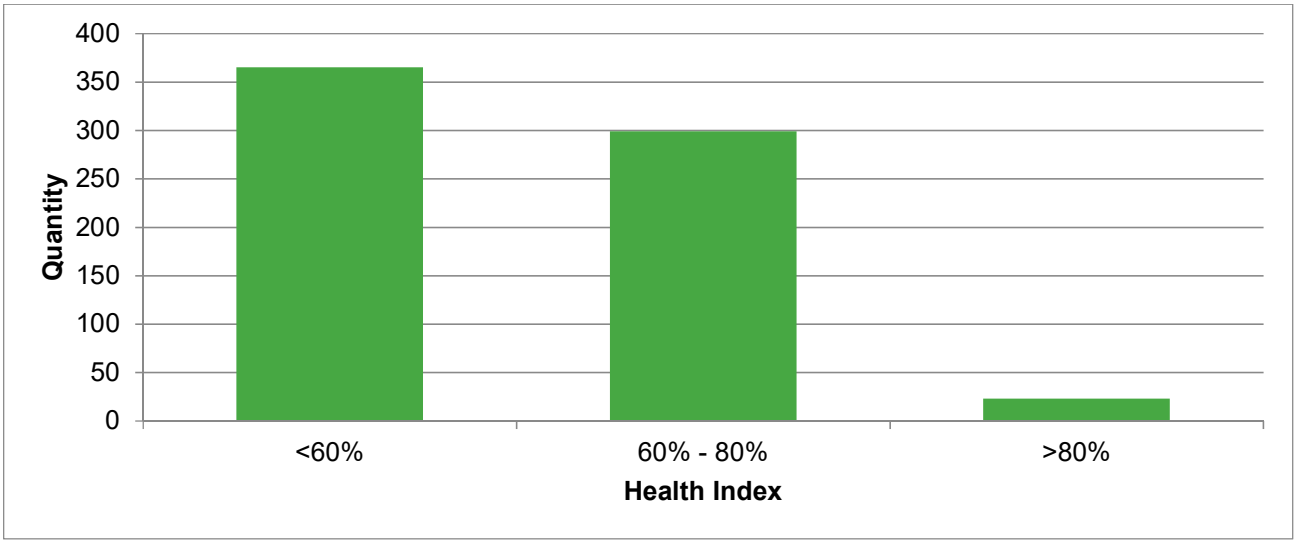


5.1.1. Metering Assets

The use of microprocessor integrated functionality meters are the standard for all new installations. This is mainly due to the value they provide us compared to the capabilities of separated functions in multiple assets. As the functions are all required to allow a metering scheme to operate, and a mandated two business day time to repair as per AEMO and NER requirements, it is best value to minimise the overall unavailability of the scheme.

The health of these assets varies and is primarily dependant on manufacturer support, spares availability, forecast defect rates, age and the technical life of the assets. The health index has been used to identify the assets that require investigation for renewal through our Capital Investment Governance Process.

Figure 11 Metering Health Index



A review of historical discrete component meter defect rates (with a three year rolling average) highlights an increasing trend. Addressing these issues is a priority for us to meet our strategic objectives. It is noted that the trend can be seen as reflective of an ageing asset base that is beyond its supportability and effectiveness. These types of meters are expected to be removed from the system within the next year.

Figure 12 Discrete Component Metering Defect Rates (%)

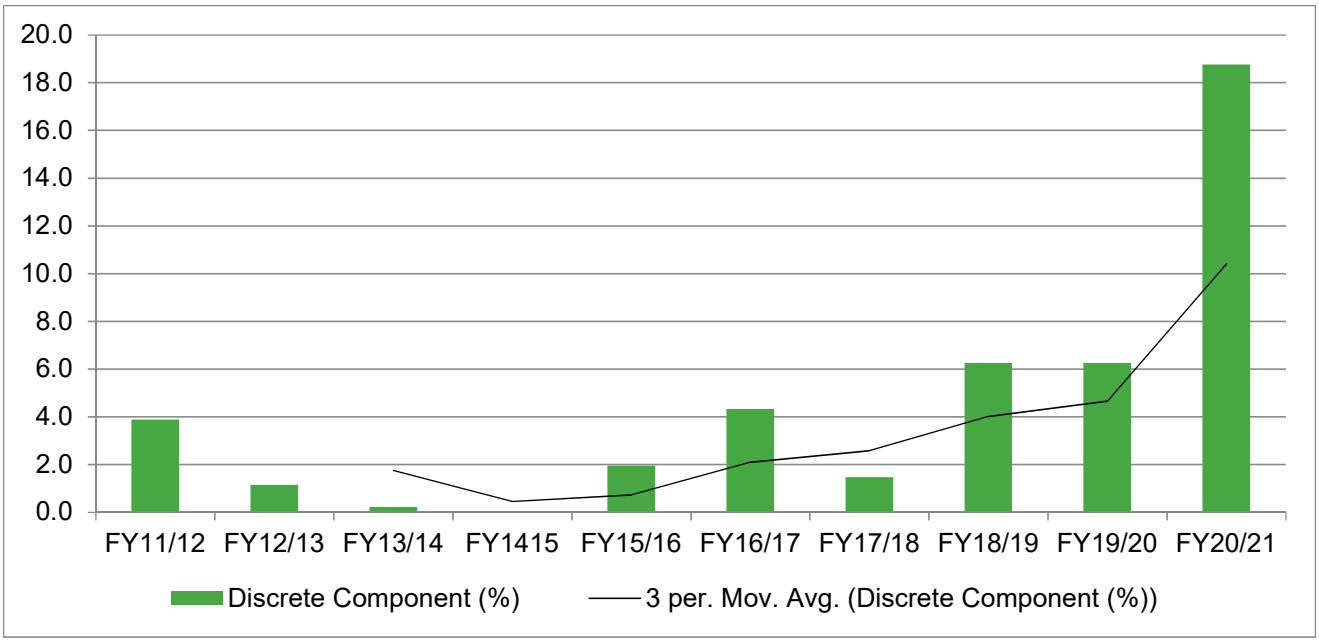
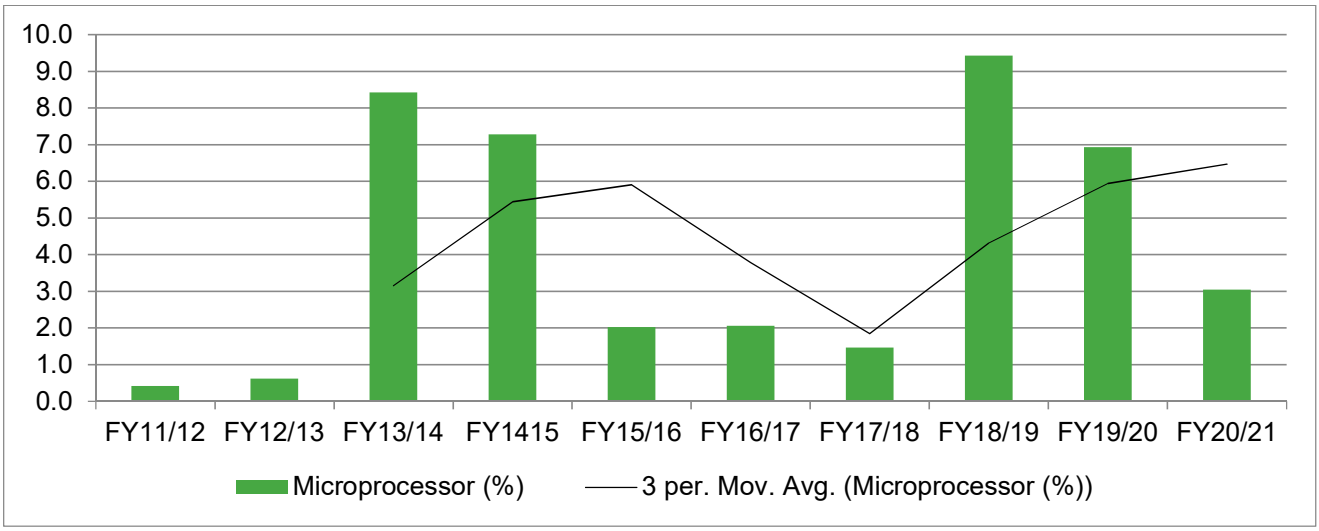


Figure 13 Microprocessor Metering Defect Rates (%)



A review of microprocessor meter defects (with a three year rolling average) highlights a spike in the defect rate. It is noted that a major component of this trend is a low population group of assets (SEL735 and EDMI Mk6 types) with a relatively high defect rate. An initial review has found that the majority of these defects were rectified by resetting the systems remotely. These meter types and defects will continue to be monitored and assessed to determine if any further actions are required.

5.1.2. Metering Modems

Defect data and population parameters are not available for metering modems at this time but are likely to be performing adequately with no significant maintenance issues being raised. However, there are a number of emerging issues that need to be addressed to meet our obligations for the provision of metering data, as detailed in section 5.2.

5.1.3. Data Loggers

Data Loggers are not actively monitored and are treated as a component of the main meter. As such no data is directly available for these assets. It is noted however that these assets are part of an older technology of metering installations, as these are replaced with modern technologies, the data loggers themselves become obsolete.

5.2. Emerging Issues and Renewal and Maintenance Initiatives

The emerging issues and renewal and maintenance initiatives to address them are summarised in Appendix A. The issues are further discussed below.

5.2.1. Metering Assets

- There is an ageing population (over 300) of EDMI MK3 type meters currently installed on the network. Many of these meters (which have been installed since 1999) are coming towards the end of technical life. Moreover, this type of meter is now discontinued and hence support and spares may become limited. It is anticipated that site wide renewals in progress (or proposed for RP3) will result in the majority of these meters being replaced. The remainder of these meters will be considered for targeted renewals in RP3.
- CT and VT accuracy checks are currently performed on all revenue meters and Type 1 check meters, in accordance with our interpretation of the regulatory requirements. However, AEMO have questioned why these accuracy checks are not being carried out for Type 2 and 3 check metering. Discussions are being held with AEMO to come to an agreeance on the maintenance requirements. The Maintenance Plan will be updated if any additional maintenance is required.
- There is currently no preventative maintenance for TUOS metering. Applicable statutory and industry best practice requirements for TUOS metering are under review to determine if there is any applicable maintenance. The Maintenance Plan will be updated if any additional maintenance is required.
- The number of defects for EDMI MK6 type meters has been significant in the last few years, particularly for a newer type of meter. An initial review has found that the majority of these defects is due to a memory failure alarm. The issue is typically rectified by resetting the meter which can usually be done remotely. This issue is being monitored and further investigation is required to determine if there is an underlying issue with the meter memory that needs to be addressed.
- Although an AEMO Metering audit resulted in no non-compliances, gaps were identified regarding the documentation of testing uncertainty processes. Formal testing uncertainty methodologies will need to be developed and maintained for the testing equipment being used. It is intended that enhancements will be made to MAP to enable linking to the uncertainty methodologies when metering tests are performed. The Maintenance Plan has been updated to ensure that testing uncertainty methodologies are kept up to date and that uncertainties are calculated and recorded for all metering equipment tests performed.

5.2.2. Metering Modems

- One model of copper line modem has had manufacturer support withdrawn. Additionally the implementation of the NBN has identified the obsolescence of PSTN copper lines from around the network. A maintenance initiative currently in practice is to replace defective PSTN modems with new 4G capable modems to transition away from the obsolete technology.
- Telstra has announced the planned withdrawal of their 3G and copper networks. This results in the removal of the current serial protocol utilised for metering dial-up by our third party Metering Data Providers. Initial investigations have concluded that a dial-up data access solution is not possible with 4G/5G. Further investigations will be initiated to develop a viable solution for providing connectivity through IP technology. This is required to meet our NER Chapter 7 obligations.

6. CAPEX Forecasts

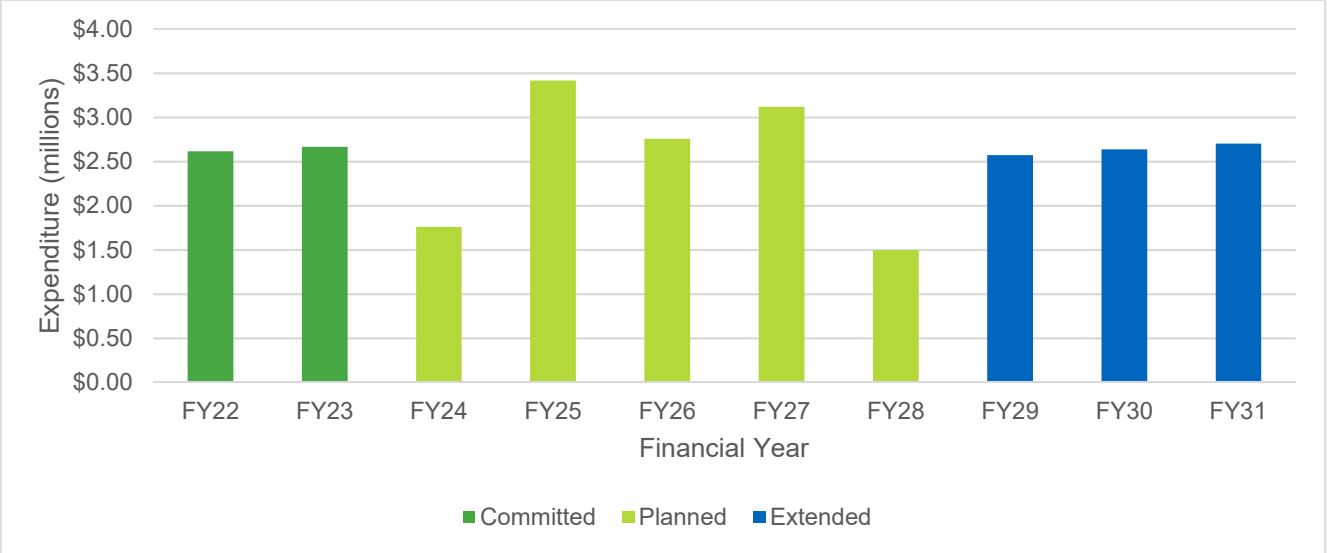
6.1. Ten Year CAPEX Profile

The projects within the digital infrastructure area of metering have been reviewed and a strategic direction established within this document.

The figure below shows the estimated ten year CAPEX forecast which consists of committed, planned and estimated expenditure:

- The committed forecast (up to and including FY23) is a bottom up build of market metering systems capital expenditure currently in the Capital program of works.
- The planned forecast is based on the proposed Capital program of works for RP3 which is being submitted to the AER for review.
- The extended forecast (from FY29 onwards) is an estimation based on the forecasted expenditure in the preceeding years

Figure 14 Ten Year CAPEX Forecast



The forecast accounts for targeted meter replacements, as well as meters replaced in site wide secondary system renewals.

6.2. Anticipated Changes to the Asset Base

The anticipated changes to the asset based have been illustrated in this section for two scenarios:

- All committed investments in the previous strategy proceeding
- No investments from this strategy proceeding

6.2.1. Metering Assets

Figure 15 Metering - Forecast Age Profile

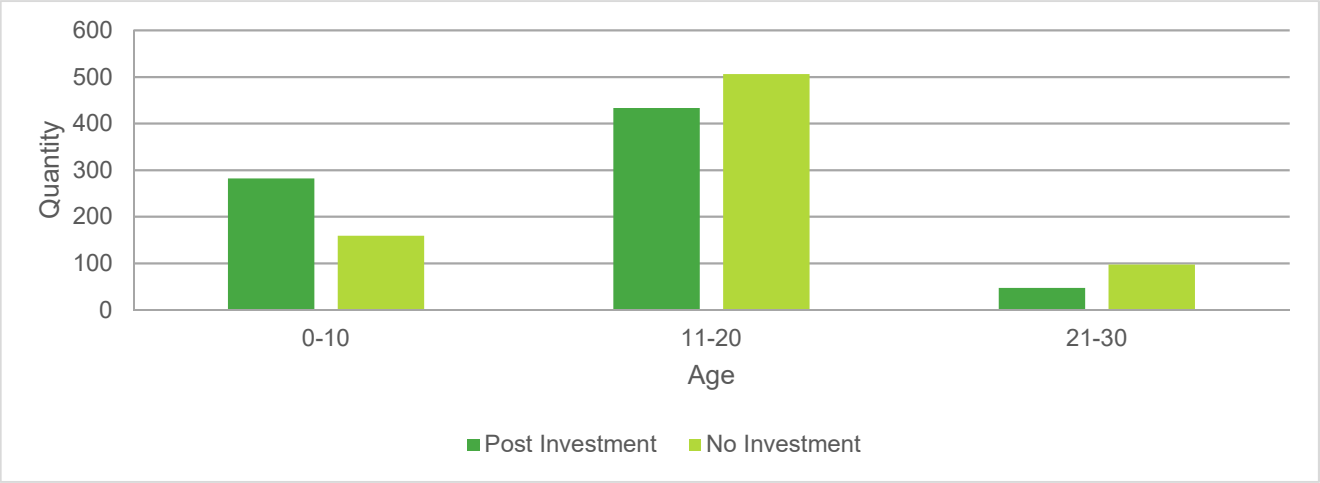
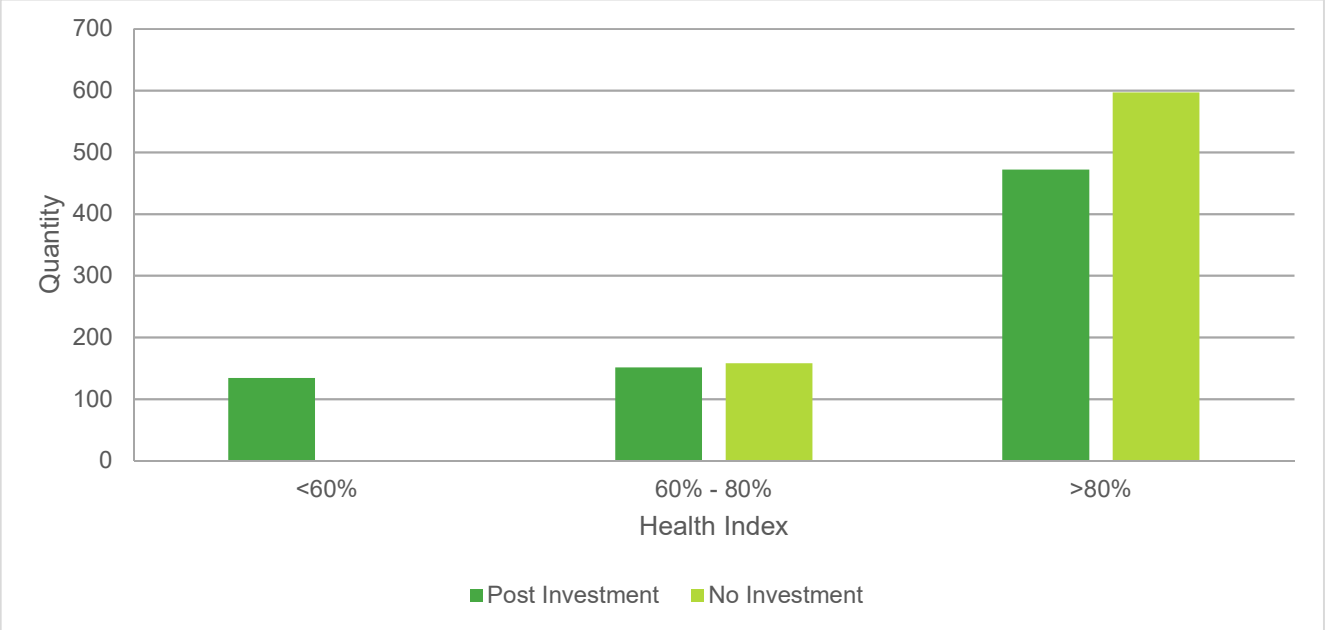


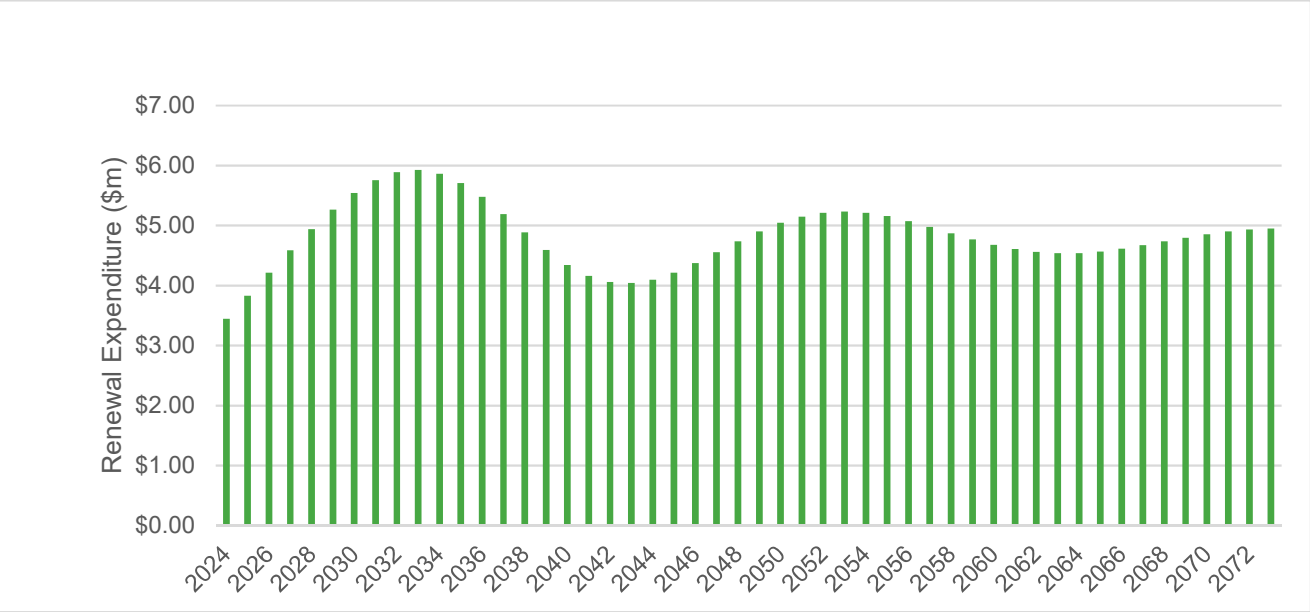
Figure 16 Metering - Forecast Health Index



6.3. Long Term - REPEX Investment Framework

The 50 Year REPEX model is used by Transgrid to create a 50 year forecast, which is based on expected asset lives, standard deviations and unit costs. The assumptions within the model are based on industry standard information. This forecast includes REPEX volumes, costs and consequential average life profiles but no other consequential inputs/outputs (such as reliability and asset health). It also doesn't include augmentation expenditure. The following output is derived from the 2020/21 model.

Figure 17 Metering Long Term CAPEX



RP2 (2018/19 – 2022/23) has been excluded as it is currently in an active system with committed works using a bottom up approach through our asset analytics tool using a number of financial and non-financial (risk) inputs.

7. OPEX Forecasts

7.1. Discussion of significant changes to Maintenance Plan

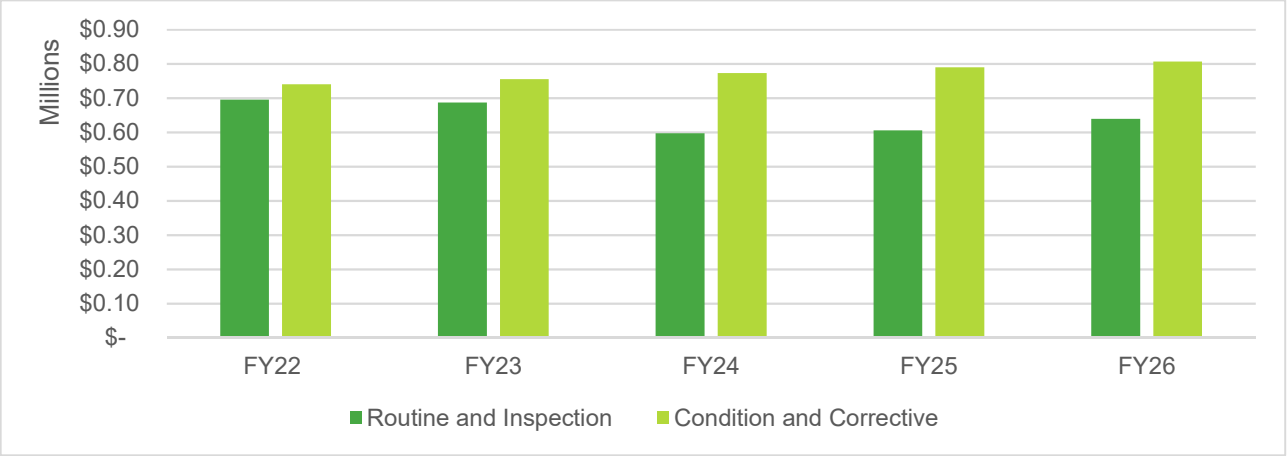
The following requirements will be included in the Maintenance Plan to address the opportunity for improvement relating to metering testing uncertainty (identified in the CAR and AEMO audit):

- Maintenance of an up to date and traceable repository of testing methodology uncertainties associated with the testing equipment being used.
- Calculation and record of testing uncertainty for all metering equipment tests undertaken, as per the relevant testing methodology.

7.2. Five Year OPEX Profile

The five year forecasted expenditure for routine and non-routine maintenance of market metering systems is shown below.

Figure 18 Market Metering Routine and Non-routine Maintenance Forecasts



7.3. Long term OPEX

The current initiatives are foreseen to maintain the long-term OPEX at a relatively consistent rate. It is expected that there will be minor peaks and troughs in expenditure. These fluctuations are the result of maintenance frequencies and convergence of various install dates.

The current and proposed initiatives are aimed at delivering efficiencies in OPEX expenditure through the removal of outage requirements. This will lead to a more predictable and consistent expenditure profile throughout the year and should minimise the probabilities of missed activities due to network constraints.

8. Implementing the Strategies

To implement the strategic renewal and maintenance initiatives stemming from this document, actions are to be established via the:

- Maintenance Plan – Market Metering Systems Assets: The Maintenance Plan outlines the routine maintenance tasks and frequencies for each asset type.
- Capital Works Program – The capital works program outlines the approved asset renewal and disposal projects.

The Asset Manager is responsible for preparation of the Maintenance Plans and referring the renewal and disposal initiative to the network investment process. Delivery/Maintenance is responsible for delivering the Maintenance Plans as per the Operating Model and Delivery/Infrastructure Development are responsible for delivering the renewal and disposal initiatives detailed in the approved capital works program.

9. Definitions

Table 7 Definitions

Term	Definition
Asset Management Objectives	• Specific and measurable outcomes required of the assets in order to achieve the Corporate Plan and objectives; and/or • Specific and measurable level of performance required of the assets; and/or

Term	Definition
	• Specific and measurable level of the health or condition required of the assets; and/or • Specific and measurable outcomes or achievement required of the asset management system.
Key Hazardous Events	They events of most concern associated with the assets that prevent the achievement of the corporate and asset management objectives.
Emerging Issues	Newly identified issues with an asset that pose a risk to the achievement of the corporate and asset management objectives.
Fault Outage	AER defined term - Fault outages are unplanned outages (without notice) on the prescribed network from all causes including emergency events and extreme events.
Forced Outage	AER defined term - Forced outages are outages on the prescribed network where less than 24 hours notification was given to affected customers and/or AEMO (except where AEMO reschedules the outage after notification has been provided). Forced outages exclude fault outages.
Asset Management Plans	Documents specifying activities, resources, responsibilities and timescales for implementing the asset management strategy and delivering the asset management objectives.
RP1	Regulatory Period 2014/15 – 2017/18
RP2	Regulatory Period 2018/19 – 2022/23
RP3	Regulatory Period 2023/24 – 2027/28
Preventative Maintenance	Maintenance activities carried out to inspect and prevent assets from failing.
Corrective Maintenance	Maintenance activities carried out to address an asset condition that requires remediation.

10. Document Management

10.1. Monitoring and review

Implementation of the Strategy is monitored and reviewed by the Asset Manager, Head of Asset Management and Asset Management Committee annually.

10.2. Roles and responsibilities to develop this Asset Strategy

The roles and responsibilities of those responsible for the development of this asset strategy are as follows:

- The Head of Asset Management is responsible for the approval of this strategy.
- This document will be reviewed by the Asset Manager in accordance with the requirements of the relevant document and records management procedure or when a material change occurs that requires its content to be updated.

10.3. References

- Asset Management System Description
- Network Asset Strategy
- Prescribed Capital Investment Process
- Maintenance Plan – Market Metering Systems
- Digital Infrastructure Spares Plan

Appendix A – Emerging Issues and Renewal and Maintenance Initiatives

Table 8 Emerging Issues and Renewal and Maintenance Initiatives

Assets	Network Asset Strategy Objective	Emerging Issues	Strategic Initiative	Progress (completion and expenditure)	Reference Documents
Metering Assets	• Manage assets efficiently without compromising security holder and customer value	• Ageing of assets • Obsolescence of technology	Renewal • Defect only replacements • Major renewals only with site wide secondary systems renewals • Targeted replacements at 3rd party sites • Targeted replacement of: - Discrete component meters with limited self-checking functionality - EDMI MK3 installations which are coming to end of life	Ongoing • Targeted replacement by 2022/23 • 13 site wide renewals by 2022/23 (RP2) • 31 site wide renewals 2023/24 - 2027/28 (RP3)	Targeted Renewals • NOSA-2134 Site wide Renewals • Refer to Appendix B
Metering Modems	• Manage assets efficiently without compromising security holder and customer value	• Withdrawal of manufacturer support of a common model • Upcoming withdrawal of copper telecommunications services from Telstra	Maintenance • Defect response - replacement of copper based modems with Mobile 4G systems	In Progress • Defect solution is case by case	• Maintenance Plan – Market Metering Systems
Metering Assets	• Manage assets efficiently without compromising security holder and customer value	• 5 minute interval rule change	Maintenance and Renewal • Implement 5 minute intervals across our metering fleet	Complete	• IWR-N2140 • IWR-N2386 • NOSA-N2359

Assets	Network Asset Strategy Objective	Emerging Issues	Strategic Initiative	Progress (completion and expenditure)	Reference Documents
Metering Modems	• Manage assets efficiently without compromising security holder and customer value	• Withdrawal of manufacturer support of current serial dialling protocol • Upcoming withdrawal of copper telecommunications services from Telstra	Maintenance • Investigation initiated into IP protocols and technology	In Progress • Initial investigations complete with an unsuccessful outcome. Further investigations required to develop a solution by June 2022.	• IWR-N2229 • IWR-N2666
Metering Assets	• Manage assets efficiently without compromising security holder and customer value	• Determination of cyber security requirements for facilitating MDP communication links to IEC61850 meters residing within the high-security SSZ environment	Maintenance • Investigation initiated into IP protocols and technology Renewal • Intermediate solution being investigated under Stockdill Dr project.	In Progress • Initial investigations complete with an unsuccessful outcome. Further investigations required.	• IWR-N2229 • IWR-N2666 • DCN335
Metering Assets	• Manage assets efficiently without compromising security holder and customer value	• AEMO has questioned why CT/VT accuracy tests for check meters (that aren't Type 1) is not currently being performed	Maintenance • Discussions being had with AEMO to determine if maintenance is indeed required. Maintenance requirements will be amended accordingly pending outcome.	In Progress • Discussions are ongoing	• Maintenance Plan – Market Metering Systems
Metering Assets	• Manage assets efficiently without compromising security holder and customer value	• Preventative maintenance is not currently performed on TUOS meters.	Maintenance • Investigation to be initiated to determine if any preventative maintenance is required in	• Not Started • Investigation to be initiated	• Maintenance Plan – Market Metering Systems

Assets	Network Asset Strategy Objective	Emerging Issues	Strategic Initiative	Progress (completion and expenditure)	Reference Documents
			accordance with statutory requirements.		
Metering Assets	• Manage assets efficiently without compromising security holder and customer value	• Defect/alarm rate is high for EDMI MK6 and SEL735 type meters which are relatively new.	Maintenance • Continual monitoring of defects for these meter types	Ongoing • Monitoring of AIM issues	• Maintenance Plan – Market Metering Systems
Metering Assets	• Manage assets efficiently without compromising security holder and customer value	• Gap identified during Metering Provider audit regarding uncertainty calculation methodology, and linking of that uncertainty to tests being performed	Maintenance • Creation of formal uncertainty calculation/statement • MAP enhancement to automatically link uncertainty statements to tests performed • Calculation and recording of uncertainties for all tests performed to be added as a requirement in the Maintenance Plan.	In Progress • Work instruction for testing uncertainty statement Completed • Requirements added to Maintenance Plan	• Maintenance Plan – Market Metering Systems

Appendix B – List of Site Wide Renewals

Table 9 Site Wide Renewals Committed in RP2

Capital Project	Reference Document
Liverpool Secondary Systems Renewal	NS-1599
Gadara Secondary Systems Renewal	NS-1260
Ingleburn Secondary Systems Renewal	NS-1255
Darlington Point Secondary Systems Renewal	NS-1253
Haymarket Secondary Systems Renewal	NS-1493
Muswellbrook Secondary Systems Renewal	NS-1247
Molong Secondary Systems Renewal	NS-1267
Marulan Secondary Systems Renewal	NS-1266
Tuggerah Secondary Systems Renewal	NS-1263
Broken Hill Secondary Systems Renewal	NS-1193
Coleambally Secondary Systems Renewal	NS-1196
Tamworth 330kV Secondary Systems Renewal	NS-1243
Deniliquin Secondary Systems Renewal	NS-1191

Table 10 Site Wide Renewals Planned for RP3

Capital Project	Reference Document
FY24-28 TTF Secondary Systems Renewal	NOSA-1194
FY24-28 YSN Secondary Systems Renewal	NOSA-N2211
FY24-28 SE1 Secondary Systems Renewal	NOSA-N2212
FY24-28 BER Secondary Systems Renewal	NOSA-N2213
FY24-28 ER0 Secondary Systems Renewal	NOSA-N2214
FY24-28 LT1 Secondary Systems Renewal	NOSA-N2405
FY24-28 GNS Secondary Systems Renewal	NOSA-N2406
FY24-28 BRD Secondary Systems Renewal	NOSA-N2407
FY24-28 AR1 Secondary Systems Renewal	NOSA-N2408
FY24-28 KS2 Secondary Systems Renewal	NOSA-N2409
FY24-28 FNY Secondary Systems Renewal	NOSA-N2410
FY24-28 WL1 Secondary Systems Renewal	NOSA-N2411
FY24-28 PMA Secondary Systems Renewal	NOSA-N2419
FY24-28 WW1 Secondary Systems Renewal	NOSA-N2426
FY24-28 RGV Secondary Systems Renewal	NOSA-N2427
FY24-28 CW2 Secondary Systems Renewal	NOSA-N2428
FY24-28 VP1 Secondary Systems Renewal	NOSA-N2429
FY24-28 FB2 Secondary Systems Renewal	NOSA-N2430
FY24-28 NAM Secondary Systems Renewal	NOSA-N2431
FY24-28 GN2 Secondary Systems Renewal	NOSA-N2432

Capital Project	Reference Document
FY24-28 TOM Secondary Systems Renewal	NOSA-N2433
FY24-28 LSM Secondary Systems Renewal	NOSA-N2434
FY24-28 NB2 Secondary Systems Renewal	NOSA-N2435
FY24-28 INV Secondary Systems Renewal	NOSA-N2436
FY24-28 COF Secondary Systems Renewal	NOSA-N2437
FY24-28 NEW Secondary Systems Renewal	NOSA-N2443
FY24-28 KCR Secondary Systems Renewal	NOSA-N2444
FY24-28 BRG Secondary Systems Renewal	NOSA-N2446
FY24-28 MPP Secondary Systems Renewal	NOSA-N2447
FY24-28 DMQ Secondary Systems Renewal	NOSA-N2448